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BUREAU OF PLANT INDUSTRY,

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WASHINGTON, D. C.

THE WORK OF THE SAN ANTONIO EXPERIMENT FARM IN 1916.[1]

By C. R. Letteer, *Farm Superintendent.*

INTRODUCTION.

The work of the San Antonio Experiment Farm was continued during 1916 along the same general lines as in previous years. The rotation and tillage experiments, which are a very important part of the work of the station, were continued without modification. The cooperative work with cotton was continued by the Office of Crop Acclimatization in the testing of the single-stalk method of culture, the time of thinning cotton when grown by this method, and the breeding and selection of improved varieties adapted to conditions peculiar to the San Antonio region. Some preliminary experiments were undertaken in the utilization of annual crops for pasture purposes. These experiments included the use of winter oats and Sudan grass as pasture crops for steers, and oats, Sudan grass, field peas, and milo for hog pasture.

[1] The San Antonio Experiment Farm comprises about 125 acres of land situated about 6 miles south of San Antonio, Tex. The tract belongs to the city of San Antonio and is leased to the Department of Agriculture. An additional 3 acres, lying immediately north of the main tract, has recently been deeded to the department for use as a permanent building site. About 80 acres of the land are under cultivation. The farm is under the direction of the Office of Western Irrigation Agriculture of the Bureau of Plant Industry and is maintained from the funds of the Department of Agriculture. For earlier reports, see the following:

Hastings, S. H. The work of the San Antonio Experiment Farm in 1912. *In* U. S. Dept. Agr., Bur. Plant Indus. Cir. 120, p. 7–20, 7 fig. 1913.

Hastings, S. H. The work of the San Antonio Experiment Farm in 1913. U. S. Dept. Agr., Bur. Plant Indus. Cir. [Misc. Pub., Doc. 1083], 15 p., 5 fig. Sept. 9, 1914.

Hastings, S. H. The work of the San Antonio Experiment Farm in 1914. U. S. Dept. Agr., Bur. Plant Indus., West. Irrig. Agr. Cir. 5 [Misc. Pub.], 16 p., 6 fig. 1915.

Hastings, S. H. The work of the San Antonio Experiment Farm in 1915. U. S. Dept. Agr., Bur. Plant Indus., West. Irrig. Agr. Cir. 10 [Misc. Pub.], 17 p., 2 fig. 1916.

Other important lines of work are the horticultural experiments, which have to do with the testing of fruit varieties, the testing of introduced fruits likely to be adapted to local conditions, and the testing of resistant stocks suitable for the soils and conditions of the region; the testing of ornamental trees and shrubs, both native and exotic, likely to be adapted to conditions and useful in the ornamentation of home grounds; the testing of varieties of the standard field crops, such as cotton and corn; the testing of varieties of flax and field peas as winter crops; experiments in different methods of culture with cotton and corn; and various related lines of work.

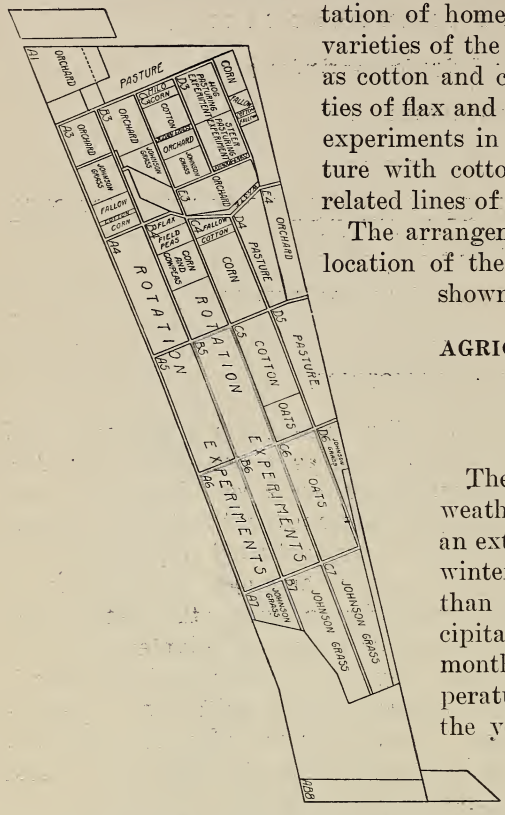

FIG. 1.—Diagram of the San Antonio Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1916.

The arrangement of the fields and the location of the experiments in 1916 are shown in figure 1.

AGRICULTURAL CONDITIONS IN THE REGION.

CLIMATIC CONDITIONS.

The main features of the weather conditions in 1916 were an extended drought during the winter and early spring, more than the usual amount of precipitation during the summer months, and nearly normal temperature conditions throughout the year. The total precipitation during the six months from January to June was 8.69 inches, which is 3 inches below the normal. Furthermore, its uneven distribution and the fact that much of it came as light showers resulted in very unfavorable crop conditions during the first six months of the year. Precipitation during the four months of July, August, September, and October was nearly twice the normal for those months. November precipitation was approximately normal, and December precipitation was very light. The total precipitation at the experiment farm for the year was 27.26 inches, which is nearly 2 inches more than the average precipitation for the 10-year period from 1907 to 1916, inclusive. The total evaporation from a free

water surface was 69.66 inches, which was somewhat above the average of 66.72 inches for the 10-year period from 1907 to 1916.

TABLE I.—*Summary of meteorological observations made at the San Antonio Experiment Farm, 1907 to 1916, inclusive.*

PRECIPITATION (INCHES).

Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Average for 10 years, 1907 to 1916	0.72	1.73	1.59	3.70	2.99	1.24	1.53	2.00	2.52	2.99	2.63	1.88	25.52
For 1916	2.30	0	.53	1.61	3.56	.69	4.72	2.25	4.16	4.48	2.58	.38	27.26

EVAPORATION (INCHES).

Average for 10 years, 1907 to 1916	2.62	3.13	4.63	5.46	6.61	8.58	9.38	9.88	6.89	5.18	3.14	2.22	66.72
For 1916	2.36	3.79	7.21	6.64	7.32	9.92	7.21	7.69	6.26	5.00	3.44	2.82	69.66

DAILY WIND VELOCITY (MILES PER HOUR).

Highest:													
1911–1916	10.4	15.9	9.3	10.6	9.2	11.9	12.1	12.61	6.6	8.5	10.05	8.00	15.9
For 1916	9.6	7.9	9.3	9.8	7.7	7.3	3.8	12.61	6.5	4.6	10.05	7.00	12.61
Lowest:													
1911–1916	.5	.1	.6	.3	.1	.5	.62	.5	.4	.3	.4	.3	.1
For 1916	.5	1.2	2.1	.4	1.06	1.64	.62	.62	.8	.4	.75	.86	.4
Mean:													
1911–1916	3.5	4.0	3.9	3.8	3.7	3.9	3.8	3.3	2.8	2.6	2.6	2.8	3.39
For 1916	4.3	3.5	4.6	5.0	4.6	4.3	1.9	3.1	2.2	2.1	2.9	3.1	3.47

TEMPERATURE (° F.).

Absolute maximum:													
1907–1916	88.5	90	95.5	102	103	108	108	105	104	98	90	84	108
For 1916	84	90	95.5	94	98	103	101	98	97	91	90	84	103
Absolute minimum:													
1907–1916	12	13	24.5	32	39	56	60	56	41	29	15	17	12
For 1916	21	20	33	35	52	64	67	63	49	71	26	18	18
Mean:													
1907–1916	53.2	54.4	62.4	67.9	75.2	82.5	84.9	84.5	79.5	69.7	60.5	50.5	68.77
For 1916	56.9	56.7	67.5	69.2	76.5	84.7	82.7	82.3	78.0	70.2	58.8	53.5	69.75

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		° F.		° F.	Days.
1907	Feb. 8	29.0	Nov. 12	32.0	277
1908	Feb. 20	24.0	Nov. 14	29.0	268
1909	Feb. 25	30.0	Dec. 6	31.0	284
1910	do.	26.0	Oct. 29	32.0	246
1911	do.	29.0	Nov. 13	31.0	261
1912	Feb. 27	30.5	Nov. 2	29.5	245
1913	Mar. 17	26.0	Oct. 27	29.0	224
1914	Mar. 23	29.0	Nov. 20	31.0	242
1915	Mar. 22	24.5	Nov. 15	27.0	238
1916	Feb. 20	32.0	Nov. 14	29.0	268

The minimum temperature during the winter of 1915–16 was 20° F. This temperature was recorded on February 2. There was no

severely cold weather, and the mean temperature for both January and February was several degrees higher than the average mean for the 10-year period from 1907 to 1916. In spite of this, more injury was done to winter crops, such as oats, field peas, and flax, than has been caused by much lower temperatures in previous years. This may be attributed to the dryness of the soil and unfavorable growing conditions and to the fact that the cold weather was preceded by several warm days. The last killing frost in spring occurred on February 20, and the first killing frost in autumn came on November 14, making a total frost-free period for 1916 of 268 days. Although there was no killing frost later than February 20, there was a rather cold period in March, when the temperature recorded was 33° F., and another in April, when a minimum of 35° was recorded.

The meteorological observations made at the experiment farm are carried on in cooperation with the Biophysical Laboratory of the Bureau of Plant Industry. Table I gives a summary of these observations for 1916, together with the means for the 10-year period from 1907 to 1916, inclusive.

CROP CONDITIONS.

In many respects the season of 1916 was very unfavorable for crop production in the San Antonio region. The dry winter and spring not only injured such winter crops as oats, field peas, and flax, but resulted in very poor soil conditions at planting time for spring and summer crops. On this account poor stands of some crops resulted, and in the case of cotton and some other crops it was not possible to plant until spring rains came, which was late in April. This was nearly a month later than the usual planting date for cotton. Scant rainfall during the early part of the season prevented all crops from making good growth, and as a result the yields of oats, milo, and Indian corn were extremely low. During the latter part of July and through August much wet, cloudy weather prevailed, resulting in very favorable conditions for the development of the boll weevil. These insects became very numerous and did much damage to the cotton crop, which, owing to late planting and unfavorable growing conditions during the early part of the season, was rather slower in development than usual. In general, the yields of cotton were low. Favorable growing conditions during the latter part of the summer resulted in good yields of late forage crops. Yields from the first cutting of forage crops, sorghum, and Sudan grass were low, and in some instances the stands were injured so severely by the drought during the early part of the season that full recuperation was not possible even when growing conditions became favorable.

ECONOMIC CONDITIONS.

Even though the yields of crops were lower than usual, the high prices prevailing made for satisfactory economic conditions. The high prices received for cotton, which is the principal cash crop of the region, resulted in general prosperity and a keen interest in increased production. The effect of low prices for cotton during the years immediately preceding was shown by more interest in diversification and the increased acreage of grain and forage crops. This interest has been intensified by the high prices of all sorts of feed crops. A very marked tendency for dairymen near the city of San Antonio to move to larger farms, making possible more home-grown feed, is evident. Previously, nearly all dairymen supplying the city depended chiefly upon purchased feed.

By the clearing of new land the cultivated area of the region is increasing gradually each year. This has resulted in increased production of all crops.

ROTATION AND TILLAGE EXPERIMENTS.

The rotation and tillage experiments, which occupy 99 quarter-acre plats, were continued without change. The season of 1916 completed the eighth crop season for most of these experiments. A few of the experiments were started in 1913. Probably the most important point brought out by the results in 1916 was the effect of the time of soil preparation upon the growth of the succeeding crop in a relatively unfavorable season.

The average yields of all crops in the rotation experiments were very low in 1916. The range of yields with each crop, however, was much greater than usual, being from practically nothing to fair yields. The average yields of all crops were much lower than in 1915 and appreciably lower than the average yields for the 8-year period from 1909 to 1916, inclusive. The average yield of milo was the lowest obtained since milo has been grown in these experiments. This was due to late planting made necessary by unfavorable soil-moisture conditions early in the season and the consequent damage by drought and the sorghum midge. The average yield of corn was next to the lowest ever obtained in these experiments, the lowest yield being that of 1910. The average yield of cotton was the lowest obtained in six years. The yields of sorghum and Sudan grass were fair.

Table II shows the crops grown in the rotation experiments, the number of plats planted to each crop, and the highest, lowest, and average yield per acre in 1916, as well as the average yields of the various crops for the 8-year period from 1909 to 1916, inclusive.

TABLE II.—*Yields per acre of crops in the rotation experiments at the San Antonio Experiment Farm in 1916 and average yields, 1909 to 1916, inclusive.*

Crop.	Unit of yield.	Average yield, 1909 to 1916, inclusive.	Yield in 1916.			
			Number of plats.	Average.	Highest.	Lowest.
Corn	Bushel	23.6	21	8.5	33.50	1.40
Dwarf milo	do	[1] 31.5	14	8.0	19.10	2.40
Oats for grain	do	12.2	8	4.5	9.80	1.60
Cotton	Pound	557.0	30	430.1	826.00	72.00
Sorghum:						
4.1-feet drills	Ton	4.32	5	3.91	5.37	2.80
8-inch drills	do	4.74	7	3.44	6.60	1.72
Sudan grass	do	[2] 5.91	2	4.38	4.49	4.27
Oats for hay	do	1.54	8	1.03	1.62	.55

[1] Five years, 1912 to 1916, inclusive. [2] Four years, 1913 to 1916, inclusive.

Though the results in these experiments continue to increase in value each year, it is yet too early to draw very definite conclusions as to which particular rotations under trial are best suited to the conditions of the region. The results do indicate, however, the advantages of rotation with all crops being grown. Not only are higher yields obtained from the various crops when grown in rotation, but observations on the experimental plats show the advantages of rotation in the control of weed pests and plant diseases. This is particularly true as regards the control of Johnson grass in uncultivated crops and the control of Texas root-rot in cotton.

Results obtained in 1916 showed very effectively the importance of early preparation of the soil in a year that was relatively unfavorable for the production of most crops. The effect of early plowing was particularly noticeable in the case of the corn crop. Corn on land plowed in July of the preceding summer, as after oats, yielded at the rate of 33.5 bushels per acre, while corn on land plowed in November, after cotton, yielded at the rate of 1.9 bushels per acre. Cotton on land plowed in July, as after oats, yielded at the rate of 674 pounds of seed cotton per acre, while cotton on land plowed in September, as after corn, yielded at the rate of 372 pounds of seed cotton per acre, and cotton on land plowed in December, as after sorghum, yielded at the rate of 246 pounds of seed cotton per acre. Milo on land plowed the previous July yielded at the rate of 19.1 bushels per acre, while milo on land plowed in November yielded at the rate of 2.4 bushels per acre. The desirability of early plowing was shown also by the yields of all other crops in the rotation experiments.

The indications were that the time of preparation was of much more importance than the effect of crop sequence or the effect of the preceding crop. This was shown very clearly by the results with corn. Corn in a 2-year rotation of corn and oats where the land was plowed in July after the removal of the oat crop yielded at the

rate of 33.5 bushels per acre, while corn in a rotation with the same crops where the oat stubble was left unplowed until November yielded at the rate of only 3.9 bushels per acre.

EFFECT OF DIFFERENT TILLAGE PRACTICES.

The results bearing on certain tillage practices are sufficiently definite to make a summary of these results of practical value. These results may be discussed under the following headings: Subsoiling, manuring, green-manure crops, biennial cropping, and the effect of rotation and tillage on root-rot in cotton.

Subsoiling.—The rotation and tillage experiments include direct comparison as to the effect of subsoiling in preparation for various crops. There are four rotations in which the effect of subsoiling on corn may be observed in comparison with four rotations which are the same except that subsoiling is not a part of the treatment; there are five rotations in which the effect of subsoiling on cotton may be observed, and one each in which the effect of subsoiling on milo and oats may be observed. A detailed report on the effect of subsoiling on the yields of several crops in the rotation experiments was published several years ago.[1] The results obtained since that time corroborate the conclusions then published. The effect of subsoiling on the yields of different crops has been variable, increasing the yields slightly in some instances and decreasing them in others. In no case, however, has the increased yield been sufficient to compensate for the extra cost of subsoiling. Usually the difference due to subsoiling has been insignificant. The results obtained in 1916 indicate that subsoiling decreased slightly the yield of corn, cotton, and oats for hay, and increased slightly the yield of milo and oats for grain. In the 7-year period, 1910 to 1916, inclusive, the average yields of all crops except oats for grain were slightly less on land subsoiled than on land not so treated.

Manuring.—The effect of manuring on crop yields has been tested in a number of rotations. Wherever manure has been used it has been applied at the rate of about 16 tons per acre. A portion of the manure used has been that produced on the experiment farm, which is hauled from the corrals at frequent intervals and composted and then hauled to the field during the fall and winter months. This manure is largely the droppings of work horses, with a small amount from cows, and with other waste material suitable for composting. The remainder of the manure used has been secured from near-by dairies. The manure from this source has been well rotted and has contained little straw or other coarse material, the practice in the locality being to keep dairy cows in corrals where no bedding material is used.

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[1] Hastings, S. H., and Letteer, C. R. Experiments in subsoiling at San Antonio. *In* U. S. Dept. Agr., Bur. Plant Indus. Cir. 114, p. 9–14. 1913.

The effect of manure on the yields of crops has varied with the crop and season. Manure has shown more beneficial results on land used continuously for the same crops than where crops are grown in rotation. It has had a more favorable effect on the yields of cotton than on those of corn and other crops. In all cases the effect of manuring, either favorable or unfavorable, has been slight. In none of the tests with manuring have the increased yields been sufficient as yet to warrant the expense of the treatment. In 1916 the average yields of all crops except oats for grain were increased slightly by manuring. When the average results for the 7-year period from 1910 to 1916 are considered, we find that the average acre yields of crops have been increased by manuring as follows: Corn, 2 bushels; milo, 8.9 bushels; and cotton, 62.7 pounds of seed cotton. The average acre yield of oats for the same period has been decreased 1.5 bushels.

Green-manure crops.—Three different plants are being used as green-manure crops in the rotation experiments. Cowpeas and rye have been used since the inauguration of these experiments in 1909, and field peas have been used since 1913. Cowpeas are grown as a summer crop following oats, and field peas and rye are grown as winter crops. On account of drought during the summer months it has generally been impossible to grow a crop of cowpeas following another crop. In only three years out of eight have cowpeas after oats grown to sufficient size to have any appreciable consideration as a green manure. It has not been possible to grow a crop of cowpeas during any season after the removal of a corn crop. On this account the growing of cowpeas has been discontinued in all rotations except two. In these two rotations cowpeas are planted after the oat crop is removed. Field peas were substituted for the cowpeas in two rotations in 1913 and were included in four new rotations started in that year, so that field peas are now grown on six plats each year. Rye is grown as a green-manure crop in one rotation.

Field peas planted in the fall of 1915 made good growth during the early part of the fall, but on account of the dry weather during the winter season the subsequent growth was slow. The field peas on all plats were injured seriously by freezing in January, which reduced the stand very materially. In consequence, the showing made by the field peas as a green-manure crop was not nearly so encouraging as in previous years. Rye planted on corn stubble made fair growth during the winter of 1916.

The plowing under of green-manure crops affected adversely the yields of most crops in 1916. Cotton grown on land on which rye was plowed under made the lowest yield in the rotation experiments, while cotton grown on land on which field peas were plowed under made somewhat lower yields than cotton in rotations that were similar except that field peas were not grown. The decreased yields in

1916 from the plowing under of green-manure crops is attributed to the shortage of soil moisture, inasmuch as the weather was dry during the interval between plowing under these crops and the time for planting the succeeding crops.

Biennial cropping.—The results from biennial cropping in 1916 were, in most instances, different from those secured in previous years. Previous to 1916 long fallow periods have had an unfavorable effect on the growth and yield of corn and cotton and a favorable effect on oats for grain. This feature of the work has been reported upon in greater detail in a previous publication.[1] The 1916 yields of corn, cotton, sorghum, and oats for grain were slightly greater on biennially cropped land than on land cropped annually. While the differences in favor of biennial cropping in 1916 were not sufficient to make the practice profitable, they were sufficient to show the value of the reserve soil moisture stored by such a practice in a very unfavorable year. The average yields of corn and cotton for the 6-year period 1911 to 1916, inclusive, have been lower on biennially cropped land than on land cropped annually to the same crops, and the average yield for oats for the same period has been somewhat greater on biennially cropped and fallowed land than on land cropped annually. With the exception of oats, the 6-year average yields of crops on both biennially and annually cropped land have been less than the average of all plats used in the rotation experiments for each crop.

Effect of rotation and tillage on root-rot in cotton.—In previous reports attention has been called to the effect of rotation and tillage practices on the spread of root-rot in cotton. Root-rot is one of the most serious problems with which farmers in the San Antonio region have to contend. It not only does much damage in cotton fields but also attacks many other plants, notably alfalfa and nearly all fruit and ornamental trees. It has been found in the rotation experiments that root-rot is less serious in cotton grown in rotation with other crops, such as corn or oats, than where the same land is used continuously for cotton production. Each year since 1913 counts of the total number of cotton plants on each plat and of the number which died from root-rot on each plat have been made.

Root-rot was more extensive on the rotation plats in 1916 than in any previous year. It is not known whether this was due to peculiar seasonal conditions or to the gradual spread of the disease. Cotton is the only major field crop grown in the rotation experiments that is susceptible to root-rot. Root-rot infection was very extensive on a large number of the cotton plats in 1916. On five different plats more than 50 per cent of the plants died from root-rot by the end

[1] Letteer, C. R. Experiments in crop production on fallow land at San Antonio. U. S. Dept. Agr. Bul. 151, 10 p., 4 fig. 1914.

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FIG. 2.—Cotton on plat B5–3, showing the widespread effect of Texas root-rot at the San Antonio Experiment Farm, in 1916.

of the season. On two plats practically all of the plants died. One of these plats is cropped continuously to cotton, and the 1916 crop was the eighth crop of cotton on the same land. The other plat was one on which cotton was grown on spring-plowed land in a 2-year rotation of corn and cotton. A few plats, however, were entirely free from root-rot infection and only small spots of root-rot were in evidence in several others.

Careful observation on the plats throughout the growing season and the results of the counts referred to above indicate very clearly the value of rotation in the control of this disease in so far as it affects cotton. On the plat that has been cropped continuously to cotton for eight years 96.2 per cent of the plants had died from root-rot by October 25 (fig. 2), while on a plat in a 3-year rotation of oats, cotton, and Dwarf milo only 2 per cent of the plants died from root-rot (fig. 3). These two plats are situated directly across the road from each other, are on the same type of soil, and it seems reasonable to believe that the difference in root-rot infection was due chiefly to the cropping system that has been practiced.

While our present knowledge of root-rot and its control is decidedly inadequate and future results may change greatly our present attitude, its seems that, in the absence of any better means of control, rotation of crops and early preparation of the land are to be recommended. It may be expected that from a continuance of the present rotation experiments additional information on the nature and control of this disease will be obtained.

EXPERIMENTS WITH COTTON.

Experiments with cotton were continued in cooperation with the Office of Crop Acclimatization. These experiments included acclimatization studies of varieties from Mexico, Central America, and Asia, tests of local and improved varieties, and cultural experiments.

As a result of adverse climatic conditions, the cotton plants were dwarfed, the size of the bolls was reduced, and consequently the bottom crop was seriously diminished. The total yield was further reduced by an unusually heavy invasion of boll weevils following the wet weather of July. This weather was also favorable to the development of boll-rot, which injured the crop to some extent.

Among the varieties tested, the Acala, a variety from Mexico, recently acclimatized by the Department of Agriculture, gave especially promising results, although the length of the lint was somewhat reduced by the drought. The Kekchi, a Guatemalan variety with some pronounced weevil-resistant characters, also yielded well. The lint of this variety is longer than that of the Acala and of high quality.

The cultural experiments included a time-of-thinning test in addition to a repetition of the tests conducted in 1915 to determine the effect on yield and quality of lint where equal numbers of plants per acre and equal numbers of plants per row were grown in rows at varying distances apart.

In the time-of-thinning test there were 80 rows 264 feet long and 4 feet apart. The field was divided into two sections (A and B), each of 80 rows 130 feet long. Each section was divided into blocks of five rows. Thinning was commenced at the south end of section A and at the north end of section B, a 5-row block at either end being thinned every third day for 48 days. The first blocks were thinned on May 7, when most of the plants were so small as to be just shed-

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FIG. 3.—Cotton on plat A5–4, showing the healthy appearance of the plants and their freedom from root-rot infection. This plat is in a 3-year rotation of oats, cotton, and grain sorghum. Only 2 per cent of the plants on this plat died from root-rot in 1916. Compare with figure 2.

ding the seed coats from the cotyledons; the last blocks were thinned so late that the plants were already in bloom. In order to secure a good stand, so as to make it possible to space the plants fairly accurately to 8 inches apart, seed was sown at a heavy rate per acre. Conditions were favorable for germination and a very thick stand was secured. For practical purposes it would have been advisable to observe the precaution of reducing to a normal stand soon after germination, in advance of the regular thinning. Severe drought had the effect of stunting the plants in the crowded rows, so that yields were less than in the rows that were thinned early. Even in these rows there was only a slight development of vegetative branches, on account of the dry weather.

The experiment conducted last year to secure data regarding the effect on yield and quality of lint where equal numbers of plants per acre were grown in rows at varying distances apart was repeated this year on a smaller scale. The experiment was in two sections, one in which thinning was done early and one in which it was delayed. There were 15 rows in each section, grouped in blocks of 3 rows each, making 5 blocks in all. The blocks were separated by guard rows. The rows in the blocks were, respectively, 3, 4, 5, 6, and 7 feet apart. The plants within the rows were spaced at distances necessary to provide uniformly the same area of land for each plant. These distances were determined on the basis of 10,000 plants per acre and varied from 17.4 inches in the 3-foot rows to 7.8 inches in the 7-foot rows. A good stand made it possible to space the plants with reasonable accuracy. Thinning in one section was done May 15, when the plants were 4 or 5 inches high and had two to four true leaves. In the adjoining section thinning was done on May 25, when the plants had five or six leaves and were beginning to produce their first 3-lobed leaves. The thick stand and extreme conditions of drought influenced this test in much the same way as the time-of-thinning test.

Where an equal number of plants per row was left in rows at varying distances apart, the results of 1916 were quite the reverse of those obtained in 1915. As in the preceding year, the yield per row increased in 1916 with the distance between the rows. But, contrary to the results obtained in 1915, the greater yields of the wider rows in 1916 were not sufficient to offset the smaller number of rows per acre. The very heavy stand interfered with the practical value of the experiment, except that it serves to demonstrate the need of a preliminary early thinning when very thick stands are obtained.

EXPERIMENTS WITH CORN.[1]

As in previous years, experimental work was conducted at the San Antonio station by the Office of Corn Investigations. Fifty-one va-

[1] This report was furnished by Mr. E. B. Brown, of the Office of Corn Investigations of the Bureau of Plant Industry.

rieties of corn, representative of the different corn-growing sections of the United States and including both early and late maturing varieties, were planted with a check variety, the Laguna. The planting was made on March 1. The most productive varieties were those requiring a medium length of season to mature. The results in 1916, as in previous years, indicate that the character of the yield is determined largely by the rainfall occurring during the pollen-shedding period. Planted about March 1, the early varieties begin to shed pollen about May 10 and the latest about June 1. In the tests at the San Antonio station, where the practice has been to plant from February 28 to March 2, good yields have been associated with good rainfall during the latter half of May. Small yields or no yields have resulted when the rainfall was short or absent at this time. A high precipitation previous to May, from February 1 to April 30, has not offset the bad effects of a deficiency during the latter half of May. The rainfall in June, except where it has occurred during the first few days of the month, has shown no correlation with the yields.

There is evident in some of the late-maturing varieties, notably in the Laguna, an inherent ability to produce well, even when the conditions have favored somewhat earlier maturing varieties, as in the past season. In 1916 the best medium-season varieties yielded from 30 to 33 bushels per acre. The Laguna averaged 28 bushels per acre, and other varieties requiring about the same length of season as the Laguna averaged 18 to 20 bushels per acre.

The method of interplanting early and late maturing varieties—that is, alternating two rows of an early-maturing with one or two rows of a late-maturing variety—reported upon in 1915, was tested again in 1916. The results indicated the method to be of practical value in localities having a light rainfall or where the distribution is erratic. Before making any general recommendation of the method, however, it is desirable to experiment further, to determine with some degree of reliability the relative stands that will give the best yields. The method in practice has given an increased yield of several bushels per acre as compared with the same varieties planted alone. Early and late maturing varieties planted in this manner do not require their maximum amounts of moisture at the same time. This apparently brings about a more economical utilization of the moisture available. Another advantage is secured in growing both early and late varieties rather than one variety, as an additional chance is afforded to secure rain at the critical period in the growth of the crop and insure against a complete crop failure.

Planting in deep furrows, kept open until the corn has reached a height of several feet, gave an increase of 6 bushels per acre and a

better quality of ears than did the same lot of seed planted level in adjoining rows.

EXPERIMENTS WITH FLAX.[1]

Preliminary experiments in growing flax as a winter crop were made at the experiment farm in 1914 and 1915. The results secured were sufficiently favorable to warrant a more extensive trial in 1916. Several varieties were grown, both in small field plats and in nursery rows. A date-of-seeding test also was made. Considering the unfavorable conditions for all winter and early spring crops, the results obtained with flax were encouraging.

Varietal test in field plats.—Five varieties were tested in field plats one thirty-fourth of an acre in size. All varieties were seeded November 26. These five varieties were a northern-grown Russian seed flax, a short fiber flax (North Dakota Resistant No. 114), and one variety each of Indian, Turkish, and Abyssinian flax. The first two were the only ones that survived the winter conditions satisfactorily. The Abyssinian variety was the least resistant and was entirely winterkilled, and the stands of the Indian and Turkish varieties were reduced by winterkilling at least 70 per cent. Differences in yield between these two varieties were due to differences in vegetative growth rather than to stand. Although North Dakota Resistant No. 114 (C. I. No. 13) was more resistant to cold and disease than the Russian variety, its growth was not so vigorous or its yield so high. The results are shown in Table III.

TABLE III.—*Yields of flax varieties in field plats at the San Antonio Experiment Farm in 1916.*

Variety.		Estimated stand.	Yield.					
			Per plat.				Per acre.	
Name.	C. I. No.		Straw.		Grain.		Straw.	Grain.
		Per cent.	*Lbs.*	*oz.*	*Lbs.*	*oz.*	*Pounds.*	*Bushels.*
Select Russian (N. Dak. No. 1215) [1]	3	75	54	2	9	14	1,949	6.4
North Dakota Resistant No. 114	13	95	34	5	7	11	1,167	4.7
Punjab	20	20	16	4	3	12	553	2.3
Smyrna	30	30	33	12	8	4	1,148	5.0
Soddo White	36	0	0	0	0	0	0	0

[1] Plat one thirty-sixth of an acre in size.

While the yields were rather low, it is thought that, owing to the extremely unfavorable conditions for fall-sown crops, the showing made is encouraging.

Varietal test in nursery rows.—Twelve additional varieties, including six of seed flax, two short fiber, and one golden flax (all northern-grown types), and one variety each of Indian, Turkish, and Abyssin-

[1] This work was conducted in cooperation with Mr. C. H. Clark, of the Office of Cereal Investigations of the Bureau of Plant Industry.

ian flax, were seeded in single nursery rows 16 inches apart and 217 feet long on the same date as the field plats. The seed was sown thickly and good stands resulted. The cold weather in January and February furnished an excellent opportunity for observing the relative hardiness of the different varieties. The Indian variety, the Punjab (C. I. No. 20), was entirely winterkilled, while the Smyrna (C. I. No. 30) and the Metcha (C. I. No. 39) were very severely injured. The stand of the Ottawa White Flowering (C. I. No. 24), the only northern variety to suffer severely, was injured about 35 to 40 per cent. Losses in stand of 5 to 10 per cent occurred in the other varieties. The yields of these eight, computed from the row yield, varied from 10.2 to 5.7 bushels per acre. Arranged in the order of the highest yield, these varieties were as follows: C. I. Nos. 18, 19, 25, 3, 12, 16, 27, and 14.

Date-of-seeding test.—North Dakota Resistant No. 114 flax (C. I. No. 13) was seeded at the rate of 25 pounds per acre at intervals of 15 days, beginning October 15. The last seeding was made on January 5. Each plat consisted of two drill rows 8 inches apart and 200 feet long. The results are shown in Table IV.

TABLE IV.—*Yields of flax in date-of-seeding test at the San Antonio Experiment Farm in 1916.*

Plat.	Date of seeding.	Estimated stand, May, 1916.	Yield.			
			Per plat.		Per acre.	
			Straw.	Grain.	Straw.	Grain.
		Per cent.	*Lbs. oz.*	*Lbs. oz.*	*Pounds.*	*Bushels.*
No. 1	Oct. 15	40	5 8	1 10	897	4.7
No. 2	Nov. 1	60	9 12	2 12	1,589	8.0
No. 3	Nov. 15	80	12 4	3 4	1,997	9.3
No. 4	Dec. 3	80	9 0	2 8	1,467	7.3
No. 5	Dec. 15	90	7 13	2 1	1,273	6.0
No. 6	Jan. 5	0	0 0	0 0	0	0

The stands in the early-sown plats were materially reduced by the freeze, and the seeding made on January 5 was completely killed out by freezing. The yields obtained indicate that the most favorable time for seeding is about November 15.

FIELD-PEA TEST.[1]

As in 1915 and previous years, a test of varieties of field peas was made to determine their suitability as a winter crop for the San Antonio region. Twenty varieties were grown in the test of 1916; each variety occupied a plat one-thirtieth of an acre in size, and the peas were planted in 8-inch drills. All varieties were planted on November 26, 1915. The peas were seeded at the rate of about 110 pounds per acre.

[1] This test was made in cooperation with the Office of Forage-Crop Investigations of the Bureau of Plant Industry, seed of the different varieties having been furnished by that office.

Good stands were secured in all the plantings. The dry weather that prevailed throughout most of the fall and winter made conditions somewhat unfavorable, and the rate of growth was much slower than usual.

One of the essentials for a suitable variety is that it be able to withstand the winter temperatures without serious injury. The winter of 1915–16 was a favorable one for testing this quality of the different varieties. Although the minimum temperature was not nearly so low as is experienced frequently at San Antonio, several varieties were killed completely by frost, and with two exceptions all varieties were injured by frost. Warm weather prevailed through the first part of January, and several showers occurred, making conditions favorable for the growth of the plants. Two cold periods, one the latter part of January and another early in February, following closely the previous warm weather, damaged the peas severely. Varieties that were killed out entirely were the Partridge, Delano, French Gray, and Bluebell. Varieties that were injured severely but not killed entirely were the Golden Vine, Kabilya, Agnes, Andes, Canadian Beauty, Piluschka, Colorado, Anderson, Scotch Blue, Berryman, Boerne, and Kerrville. The last three were varieties that had been grown for some years in the locality. The Gray Winter variety was uninjured by either cold period, and the Kaiser, though slightly frosted at the growing point, survived the cold without serious injury. The variety test in 1915, when no winterkilling occurred with any varieties, indicated that these two varieties were very promising. The fact that they are much hardier than the other varieties adds greatly to their value and indicates their suitability for San Antonio conditions.

Conditions during the spring were very unfavorable for the growth of the peas, and none of the varieties grew well. The Kaiser and the Gray Winter varieties made the best growth of vines, but neither produced very satisfactory yields. The Kaiser variety yielded at the rate of 2,100 pounds of cured vines and 3.8 bushels of peas per acre. The yield of the Gray Winter variety was at the rate of 1,800 pounds of vines and 1.25 bushels per acre. The Kaiser proved to be much the best yielder of seed. The strain that was grown under the name of Kerrville appears promising. Even though injured somewhat by frost, it made a yield of 960 pounds of vines and 2.5 bushels of seed per acre. It was also considerably earlier than many of the other varieties, which is a desirable characteristic, especially when grown for green manure or for seed production.

HORTICULTURAL EXPERIMENTS.

The horticultural experiments consist of testing varieties of fruits, methods of culture for fruit crops, the testing and acclimatization of foreign fruit and nut trees likely to be adapted to local condi-

tions, and the testing of various plants suitable for stocks on which to bud or graft the improved varieties. Practically no additions were made to the collections in 1916, and the work for the season was confined to making observations on the plants and trees already growing in the station orchards.

Conditions were very unfavorable for orchard crops, owing to lack of moisture during the period when trees make the major portion of their yearly growth, that is, in the spring and early summer. More trees than usual died as a result of the unfavorable conditions, and much of the fruit was small and poorly developed. This was especially true of the varieties that ripened before the rains came, about July 15.

Peaches.—In the variety orchards the following varieties of peaches bore fruit in 1916: Honey, Tuskena (*Tuscan*), S. P. I. No. 26824, May Honey, Stanley, Clara, Colon, Imperial, Pallas, Florida Gem, and Triana. In addition to the named varieties, the Mexican seedlings that have been distributed under S. P. I. Nos. 32374 and 32379 bore large crops of fruit. As there are 63 different varieties of peaches being tested at the station, it is seen that a great many of them produced no fruit in 1916.

Plums.—Several of the older plum trees in the variety orchard died during the season of 1916, and the others bore practically no fruit. A few of the younger plum trees representing varieties not previously tested at the station bore fruit for the first time in 1916.

Miscellaneous.—The jujubes bore a heavy crop in 1916. The jujube is a very promising fruit under the conditions at San Antonio, and an effort is being made to assemble at the station an extensive collection of the large-fruited varieties grown in China. Nearly all varieties of Japanese persimmons bore a good crop. The persimmon is one of the surest bearers at the station and eventually should become a common fruit in the San Antonio region. None of the varieties of almonds, apricots, olives, pistaches, pears, or quinces bore any fruit in 1916. Small crops of pomegranates and figs were produced. The Rusk citranges bore a very heavy crop of fruit, and the Cunningham citranges bore fruit for the first time. In addition to the fruits discussed above, a few trees of walnuts, cherries, prunes, nectarines, and plumcots are being grown, but none of these produced fruit in 1916.

Ornamentals.—Much attention is given to securing plants suitable for growing as ornamentals. Owing to the climatic and soil conditions, many of the more common ornamental plants grow very poorly or are extremely short lived. Texas root-rot is probably the most serious obstacle to the growing of many ornamentals. Palms seem to be immune to the disease; at least, they do not die from it,

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FIG. 4.—Morning-glory vine with yellow flowers at the San Antonio Experiment Farm; species so far undetermined. (Photographed in November, 1916.)

and there appears to be a certain range of susceptibility between various species of other plants. Large numbers of foreign species are being tested as ornamentals, and as rapidly as possible various native trees and shrubs are being collected and assembled on the station grounds for observation under domestication.

Fairly satisfactory progress is being made in this endeavor, and observations on the work indicate that there may be a fairly wide range for the selection of plants suitable for the ornamentation of home grounds. A large number of palms are hardy under the climatic conditions at San Antonio, and these are especially suitable for home planting. Several species of Ligustrum (privet), which are evergreen, are being grown at the station, and these grow well and make very ornamental plants. Several other evergreens, such as species of Euonymus, certain arbor vitæs, locusts, a native laurel, *Sophora secundifolia*, and a native Berberis, have proved well adapted to conditions and should be grown. Many evergreen fleshy plants with low water requirements, such as agaves, yuccas, and cacti, are well adapted to the conditions. Many species of deciduous trees and shrubs also appear to do well when provided with suitable growing conditions. Some of the more promising are the hackberry, mulberry, umbrella tree, desert willow, Texas redbud, crape myrtle, Vitex, and flowering pomegranates.

Among the ornamental plants lately added to the collection at San Antonio is a very luxuriant-growing morning-glory vine (fig. 4). This plant is an undetermined species of Ipomoea, with very large

leaves and large yellow flowers. It makes a very luxuriant growth the first part of the season and is a profuse bloomer during the latter part of the summer and fall. At San Antonio all the first flowers drop off, and not until extremely late in the season do any seeds form. Both years it has been grown the vines have been killed by frost before any of the seed matured. The vine is killed to the ground by the first killing frost, but new growth takes place from the old root early the following season. The vine shown in the illustration was planted in the spring of 1915.

EXPERIMENTS IN CROP UTILIZATION.

Heretofore the principal activities of the San Antonio Field Station have been in the direction of finding new crops and methods adapted to local conditions, the end in view being to increase crop production. As the production of feed crops increases, owing to greater acreage and better methods of farming, it is to be expected that eventually more of such products may be grown than readily can be marketed locally. The problem then will be the utilization of such products on the farm in the production of live stock. In order to obtain certain information bearing on this phase of the agriculture of the San Antonio region, preliminary experiments in the utilization of pasture, hay, and grain crops for growing hogs and beef cattle were begun in the autumn of 1915.

HOG-PASTURING EXPERIMENTS.

The hog-pasturing experiments were conducted to ascertain the value of winter oats, field peas, and Sudan grass when pastured with growing pigs and the pigs fed a supplementary grain ration of ground milo. The use of Dwarf milo as a hogging crop was also a feature of this work. A little more than 1¾ acres of land and eight pigs were used in this experiment. For winter pasture two quarter-acre plats of winter oats and two quarter-acre plats of field peas were used. The oats were planted on October 21, 1915. One plat of peas was planted at that time and one plat at a later date, November 18. Two quarter-acre plats of Sudan grass were used for summer pasture, the plan being to have the Sudan grass ready for pasturing when the oats and field peas were gone. Sudan grass was planted on one plat March 14 and on the other April 24. One-third of an acre was planted to Dwarf milo on March 13. Each plat used in the experiment was fenced separately and the pasturing on the various plats was rotated, depending upon the size and condition of the crop. Except when the pigs were hogging off the field peas in the spring and Dwarf milo in the summer they were fed a grain ration of 2 per cent ground milo, that is, 2 pounds of grain a day per 100 pounds of live weight, the pigs being weighed at weekly intervals and a correction in the grain ration made after each weighing.

Conditions during the entire season were so unfavorable for the growth of the pasture crops that several times the crops were pastured very close and failed to furnish sufficient feed to keep the hogs in good growing condition. This made the results unsatisfactory in many respects, and they should not be considered as conclusive. The hogs used in this experiment were of mixed breed and were purchased in the vicinity of the station. They were rather small at the beginning of the experiment, being about 6 or 8 weeks old and weighing an average of 35 pounds each.

Winter oats and field peas.—From December 18, 1915, to May 8, 1916, the hogs had the use of one-half acre of winter oats and one-half acre of field peas. As mentioned earlier in this report, the conditions during the winter and early spring were very unfavorable to crop growth. The peas were injured severely by freezing, the stands being reduced at least 60 per cent. The oats also were frozen back slightly on one occasion. During this entire period the hogs were pastured on the peas only 7 weeks, but they were on the oats a total of approximately 13 weeks. The hogs received a 2 per cent grain ration of ground milo during the entire period, except during the two weeks between April 10 and April 24, when they were on the field peas. When the experiment was planned it was expected that the field peas would produce so much grain that a supplemental grain ration would not be necessary at this time. The peas, however, produced practically no seed.

Sudan grass pasture and Dwarf milo.—Two quarter-acre plats of Sudan grass and one-third acre of Dwarf milo were used by the hogs from May 8 until September 7, when the supply of pasture was exhausted and the hogs were removed to a dry lot. Except during a 12-day period when the hogs were on the one-third acre of Dwarf milo they were pastured on Sudan grass and were fed a 2 per cent grain ration of ground milo. While on the milo no supplemental grain ration was fed. During the greater part of this period the one-half acre of Sudan grass furnished sufficient pasturage for the eight hogs. The grass was eaten rather close at times and also became rather dry. Whenever the grass became dry and was not in good growing condition the gains made by the hogs were much smaller than at other times.

The one-third acre of Dwarf milo was very poor on account of a poor stand; the stand was thickened by replanting, but this was done so late that practically none of the plants from the replanting produced grain. Birds also damaged the milo seriously. By comparing it with another plat of milo at the station from which a weighed yield of grain was obtained it was estimated that the one-third acre of Dwarf milo would have yielded approximately 4 bushels of grain, or at the rate of 12 bushels per acre. During the first week

the hogs were on the milo they gained a total of 52 pounds, which at 7 cents a pound would be worth $3.64, making the milo worth $10.92 per acre.

STEER PASTURING.

The object of the steer-pasturing experiment was to determine the value of winter oats and Sudan grass for pasturing beef cattle. The plan of the experiment also involved the feeding of sorghum or Johnson grass hay at such times as sufficient feed was not provided by the pasture crops.

Two yearling steers purchased in the vicinity of the station were used in this experiment. They were Red Polled grades of fair quality. One and one-half acres of land were used for the pasture crops. The entire area, or six quarter-acre plats, was seeded to winter oats on October 21, 1915. The land had been in grain-sorghum varieties in 1915, but was plowed early, so that the soil was in fair condition when the oats were seeded. The oats made a fairly good growth, although they were injured somewhat by frost at one time and, due to drought, stopped growth rather early in the spring, thereby lessening very materially the pasturage they ordinarily would furnish in the spring. The entire area was divided into three pastures, and these were grazed in rotation, changes from one pasture to another being made at intervals, depending upon the condition of the crop.

The pasturing of oats was started on December 20, 1915, and continued without interruption until March 6, when the crop was eaten very close and it was necessary to remove the steers.

On February 16, when the steers had eaten the oats very close, the first pasture was plowed in preparation for planting to Sudan grass for summer pasture. The soil was very dry and hard at this time. The second pasture was plowed on March 16 and the third on May 3. The soil was so dry that it was not possible to seed Sudan grass until after the rains came in April. On April 24, Sudan grass was seeded in two of the pastures. The pasture that was plowed first was in fair condition for planting, but the soil in the other pasture was still dry. Sudan grass was not planted in the third pasture until May 4.

The soil moisture had been exhausted so completely by the oats during the winter that the Sudan grass was entirely dependent upon the precipitation that occurred during its growing season. On account of the unfavorable conditions, many of the plants died from drought after they had reached a height of several inches. This reduced the stand materially, and the general conditions were extremely unfavorable for the growth of the grass. It was necessary therefore to remove the steers from the pasture several times in order to permit the grass to make growth. During such times the steers were kept in a dry lot and fed as much Johnson grass hay as they would eat. The changes from pasture to dry feed complicated the

experiment to such an extent that it is extremely difficult to determine the value of the Sudan grass pasture or the value of the dry-hay feed.

In view of the preliminary character of these pasturing experiments and the extremely adverse conditions of the season, it seems inadvisable to draw conclusions from the results obtained. These results indicate that it should be possible to work out a combination of pasture crops and silage crops with which to carry live stock economically through the year. Further experimentation is needed, however, before final recommendations can be made.

Approved:

WM. A. TAYLOR,
Chief of Bureau.

JULY 16, 1917.

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